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ELECTROCARDIOGRAPHIC CHANGES IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS CORRELATION WITH AIRFLOW LIMITATION

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Abstract

BACKGROUND-We want to study electrocardiographic changes in chronic obstructive pulmonary disease and its correlation with airflow limitation

METHODS- It was a cross-sectional observational prospective study conducted on Patients hospitalized at the Govt General Hospital Dept of General Medicine and in collaboration with Pulmonary Medicine, Kurnool Medical College, Andhra Pradesh, during the period from January 2022 to December 2022

RESULTS- Among 50 cases, 40 males and 10 females were observed between the ages of 51 and 80 years. The average BMI was 21.8 kg/m2. Smoking habits are seen in all males. Females had a history of exposure to bio-combustibles. Among the COPD cases, the majority (40%) were belonging to severe airflow limitation (GOLD C), followed by very severe (32%), moderate (22%), and mild (6%) categories. Most of the patients (40%) were in GOLD stage C, with Right ventricular hypertrophy being the most prevalent ECG abnormalities (52%). The Mean FEV1% in mild is 81.3 +0.57, moderate is 63.9+6.28, the Mean FEV1 in severe is 41.15±4.59, and in Very Severe 25.625±2.41. The overall mean FEV1 % was 43.6±17.48% which was statistically significant (P <0.05). The present study shows 42% of patients had FEV1/FVC ratio between 41-60, as most of the patients belong severe degrees of airflow limitation. The most important risk factor for COPD is smoking, which is present in 80%of COPD patients (mean pack of 20.67±6.5 years). The study showed a majority of the patients had abnormal ECG, in which the most common ECG change was Right ventricular hypertrophy which was present in 52% of cases, followed by RBBB in 40%, Right axis deviation in 34% of patients, P pulmonale in 32%, and Atrial Fibrillation observed in 22%. The severity of the disease was associated with all ECG abnormalities (p<0.05). Upon ECG change, RVH was detected in 1 case of mild category, and 50%, 36.36%, and 68.75% of severe, moderate, and very severe category patients. P. Pulmonale was found in 9.09%, 20%, and 68.7% of moderate, severe, and very severe patients. RAD was found in 9.09%, 50%, and 37.5% of moderate, severe, and very serious patients. Poor R wave progression was noted in 9.09%, 20%, and 56.25% of moderate, severe, and very severe patients. RBBB was seen in 18.18%, 35%, and 68.75%of moderate, severe, and very severe patients, respectively. Patients in the moderate, severe, and very severe categories had 18.18%, 15%, and 37.5%, respectively. ECG results were correlated statistically with the length of symptoms. 'p' pulmonale, right axis deviation, RVH, and RBBB all increased with the duration of the condition. FEV1/FVC values were found to have a negative connection with the occurrence of certain electrocardiographic characteristics. (r=-0.594, -0.710, -0.661, - 0.176, and -0.374 for P-wave axis > +90°, QRS-axis >+90°, P-wave height > 2.5 mm in lead II, R wave in V1 > 7 mm, and RBBB). COPD patients with a poor FEV1/FVC% ratio had more ECG abnormalities..

CONCLUSION: ECG alterations were associated with a low FEV1/FVC ratio in COPD cases. Low FEV1/FVC ratio values were associated with ECG abnormalities. As the duration/severity

of the disease rise, ECG abnormalities become more common. Hence, all COPD patients should undergo cardiac evaluation using an electrocardiogram to detect early cardiac abnormalities to prevent cardiac mortality and morbidity.

KEY WORDS-COPD(chronic obstructive pulmonary disease),ECG(Electrocardiogram).

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INTRODUCTION-

ECG changes occur in COPD due to: The long-term effects of hypoxic pulmonary vasoconstriction upon the right side of the heart, causing pulmonary hypertension and subsequent right atrial and right ventricular hypertrophy (i.e., core pulmonale). Many investigations have shown that COPD has considerable extrapulmonary (systemic) consequences, the most prevalent of which are cardiac symptoms. [1,2]. If FEV1 is greater than 50% of anticipated, cardiovascular illness contributes to half of all hospitalizations and a third of all fatalities[5]. Cardiovascular illness accounts for 20%–25% of all deaths in COPD patients with advanced disease.

Various processes contribute to the ECG changes that accompany increasing airway obstruction in COPD including (a) Lung hyperinflation, which may alter transmission or cardiac action in current circumstances. (b) Diaphragm depression, which may change the heart anatomic connection to the electrode placements. (d) Pulmonary hypertension is caused by vasoconstriction.

Airflow obstruction is characterized as mild (Gold 1), moderate (Gold 2), severe (Gold 3), or very severe (Gold 4) based on post-bronchodilator FEV1.10.Comorbidities can also arise in patients with mild, moderately severe, or severe airflow limitation and demand specific therapy [3,4]. By taking all these considerations, the current study was designed to assess the clinical and ECG changes in COPD patients at our tertiary care centre

AIMS AND OBJECTIVES

Aim: The goal of this study is to analyze the ECG changes in COPD patients and their correlation with airflow restriction.

Objectives:

1. To identify electrocardiographic changes in COPD patients.
2. To analyze the correlation between electrocardiographic changes and pulmonary function test findings in COPD.

MATERIALS AND METHODS –

Study design -It was a cross-sectional observational prospective study. All participants in the study gave their informed permission. Source of data Patients hospitalized at the Govt General Hospital Dept of General Medicine and collaboration with Pulmonary Medicine, Kurnool Medical College, Andhra Pradesh.
Randomization: Simple random sampling Sample size calculation $\sigma = 0.1$ standard deviations. For, a 95% confidence interval, $Z = 1.96$, 5% significance level, $E = 0.04$ = Allowable error. Therefore, the required sample size, with $n = \{Z2 \times \sigma 2\}/E2$ was 50.
Inclusion criteria: COPD diagnosed cases: 50 COPD patients diagnosed by symptoms and confirmed by radiographic and pulmonary function tests were included randomly.
Exclusion criteria: Bronchial asthma, Bronchiectasis, and Pulmonary tuberculosis. Known congenital or acquired heart diseases, Diabetes mellitus, and Hypertension.

Study duration: 12 Months, duration from JANUARY 2022 to DECEMBER 2022.
Measurements: ECG Pulmonary function tests. Chest x-ray, HRCT Chest, and other necessary investigations
ECG criteria for right ventricular hypertrophy:
1. RAD of QRS
2. P-pulmonale
3. R<S in V6
4.A+R-PL>0.7; ; A=maximal R/Amplitude in V1 or V2, R=maximal S in lead I or V6, PL=minimum S in V1 or minimal R in lead I or V6.

ECG criteria for corpulmonale
1. Right axis deviation of QRS complex
2. P-pulmonale
3. With rSR in right precordial leads and QRS duration >0.12 seconds, the right bundle branch block (incomplete) occurs.
4. R/S-ratio in V1>1. Dominant „R" wave in the right precordial leads

5. R/S-ratio in V6. RV dilatation and strain have been used to explain the inversion of the 'T' wave in the right leads. Hypoxia-related generalized T wave inversion could be a nonspecific condition.

Spirometry is performed on patients who meet the inclusion and exclusion criteria.

Statistical analysis:

Continuous variables were expressed as means and standard deviations, and categorical variables were represented by percentages. One-way ANOVA or a chi-square test was used to identify the differences in baseline characteristics. To assess the risk developed in each GOLD stage, unadjusted and adjusted Odd Ratios with a 95 %CI were determined for each ECG variable. The association between COPD duration and smoking status with various ECG abnormalities was investigated using ORs with a 95% CI. Pearson's correlation coefficient "r" was used to examine the correlation between two variables. SPSS software version 23.0 was used for statistical analysis (IBM, Chicago, Illinois).

RESULTS-

Table1: Age Distribution in COPD patients

Age (years)	Mild (n=3)		Moderate(n=11)		Severe (n=20)		Very severe (n=16)		Total (n=50)	
	No	%	No	%	No	%	No	%	No	%
41-50	1	33.33	2	18.18	1	5	0	0	4	8
51-60	1	33.33	3	27.27	5	25	4	25	13	26
61-70	1	33.33	4	36.36	5	25	4	25	14	28
71-80	0	0	2	18.18	6	30	5	31.25	13	26
> 80	0	0	0	0	3	15	3	18.75	6	12
Mean Age	53.3 ± 7.09		60.45± 8.3		66.9± 9.09		68.75± 8.73		65 ±9.4	

Table2: Sex Distribution in COPD patients

Sex	Mild (n=3)		Moderate (n=11)		Severe(n=20)		Very severe (n=16)		Total (n=50)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Males	2	66.67	8	72.72	16	80	14	87.5	40	80
Females	1	33.33	3	27.27	4	20	2	12.5	10	20

Table3: Distribution of BMI in the study group

COPD Patients	Range	Mean BMI(Kg/m2)
Mild	18-26	22.3 ± 4.04
Moderate	18-28	21.9 ± 5.37
Severe	18-27	22.1± 2.53

Very Severe	16-26	20.3 ± 1.36
Total	16-28	21.8

Table4: COPD Association with Smoking

Smoking (Pack Years)	Number of patients	Percentage (%)
20	7	14
20-25	15	30
25-30	10	20
>30	9	18
Other modes	9	18

Table 5: Duration of Illness of COPD

Duration	Mild (n=3)		Moderate (n=11)		Severe(n=20)		Very severe (n=16)		Total (50)	
Years	No.	%	No.	%	No.	%	No.	%	No.	%
<5	3	100	3	27.27	3	15	6	37.5	15	30
5-10	0	0	4	36.36	8	40	6	37.5	18	36
10-15	0	0	2	18.18	6	30	2	12.5	10	20
>15	0	0	2	18.18	3	15	2	12.5	7	14s

Table 6: Comorbidities among COPD patients

Comorbidities	Number of patients	Percentage (%)
Diabetes mellitus	18	36
Systemic hypertension	22	44
History of tuberculosis	10	20

Table 7: Distribution of presenting symptoms in COPD patients

Symptoms	Number of patients	Percentage (%)
Shortness of breath	50	100
Cough and sputum	40	80
Wheeze	26	52
Chest discomfort	22	44
Fever	21	42

Table 8: Distribution of Clinical Signs among COPD Patients

Signs	Mild		Moderate		Severe		Very severe		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Tachypnea	3	100	11	100	20	100	16	100	50	100
Cyanosis	1	33.33	2	18.18	4	20	3	18.75	10	20
Swelling of feet	0	0	0	0	4	20	5	31.25	9	18
Raised JVP	0	0	0	0	2	10	6	37.5	8	16
Hyperresonant chest	1	33.33	8	72.72	14	70	8	50	31	62
Wheeze	0	0	4	36.36	12	60	10	62.5	26	52
Crepitations	1	33.33	5	45.45	8	40	10	62.5	24	48
Usage of accessory muscles	0	0	0	0	8	40	11	68.75	19	48
Obliteration of cardiac and liver dullness	0	0	4	36.36	11	55	11	68.75	26	52
Loud p2	0	0	1	9.09	8	40	11	68.75	20	40
Parasternal heave	0	0	0	0	8	40	8	50	16	32
Tricuspid regurgitant systolic murmur	0	0	1	9.09	8	40	10	62.5	19	38
hepatomegaly	0	0	0	0	1	5	4	25	5	10

Table 9: Distribution of FEV1% among COPD Patients

COPD	FEV1%		P-value
	Range	Mean+SD	
Mild (n=3)	82-81	81.3 ± 0.57	<0.0001 (very high significant)
Moderate(n=11)	74-51	63.9± 6.28	
Severe(n=20)	49-32	41.15± 4.59	
Very Severe (n=16)	29-21	25.625± 2.41	
Total	82-21	43.6± 17.48	

Table 10: Distribution of COPD cases according to FEV1/FVC%

FEV1/FVC%	Number	Percentage	Mean FEV1/FVC
10-20	--	--	--
21-30	6	12.0	27.67±3.3

31-40	11	22.0	37.9±2.4
41-50	15	30.0	46.2±2.5
51-60	6	12.0	56.8±3.3
61-70	12	24.0	65.5±2.8
TOTAL	50	100.0	48.1±.12.9

Table 11. Logistic regression analysis of variables between PH and non-PH group:

Variables	Adjusted odds ratio	95% confidence interval	P-value
BMI	0.76	0.59 – 0.98	0.04
Smoking pack years	1.024	0.99 – 1.05	0.13

Table 12. ECG changes with disease severity of COPD

COPD stages	Frequency of patients ECG changes
Mild(n=3)	1(33.33%)
Moderate (n=11)	5(45.45%)
Severe(n=20)	11(55%)
Very severe(n=16)	15(93.75%)

Table 13: Distribution of Electrocardiographic Findings

ECG Changes	GOLD 1 Mild		GOLD 2 Moderate (11)		GOLD 3 Severe (20)		GOLD 4 Very Severe (16)		Total	
	No	%	No	%	No	%	No	%	No	%
P Pulmonale	0	0	1	9.09%	4	20%	11	68.7%	16	32%
Poor R wave progression	0	0	1	9.09%	4	20%	9	56.25%	14	28%
Right Axis Deviation (RAD)	0	0	1	9.09%	10	50%	6	37.5%	17	34%
Low voltage ECG (%)	0	0	2	18.18%	7	35%	11	68.75%	20	40%
Right Ventricular Hypertrophy (RVH)	1	33.33%	4	36.36%	10	50%	11	68.75%	26	52%
RBBB	0	0	2	18.18%	7	35%	11	68.75%	20	40%
S1Q3	0	0	1	9.09%	2	10%	3	18.75%	6	12%

S1S2S3	0	0	2	18.18%	7	35%	11	68.75%	20	40%
Atrial Fibrillation	0	0	2	18.18%	3	15%	6	37.5%	11	22%

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Table 14: ECG abnormalities in COPD cases

	Criteria	No	Percentage
P-wave axis	<900	23	46.0
	≥+900	27	54.0
QRS axis	<900	30	60.0
	> +900	20	40.0
P wave height in mm	<2.5	31	62.0
	≥2.5	19	38.0
R V6 height in mm	>5.0	30	60.0
	≤5.0	20	40.0
RBBB	Absent	30	60.0
	Present	20	40.0
RV1 height in mm	<7	36	72.0
	>7	14	28.0

Table 15: Comparison of ECG changes mean values of FEV1

	Criteria	No=50	FEV1 (Mean ±SD)	P-value
P-wave axis	<900	23	1.32±0.35	0.0029(sig)
	≥+900	27	1.04±0.28	
QRS axis	<900	30	1.28±0.33	0.0002(sig)
	> +900	20	0.94±0.24	
P wave height in mm	<2.5	31	1.32±0.30	<0.0001(sig)
	≥2.5	19	0.87±0.17	
R V6 height in mm	>5.0	30	1.25±0.34	0.0001(sig)
	≤5.0	20	0.89±0.17	
RBBB	Absent	30	1.16±0.34	<0.0001(sig)
	Present	20	0.86±0.00	
RV1 height in mm	<7	36	1.15±0.34	0.2797
	>7	14	1.05	

Table 16. Relationship of the Duration of COPD with ECG Abnormalities

ECG Abnormality	Duration (Years)				Test for
	0-5	06-11	12-15	>15	

						Trend
P-Pulmonale (%)	Unadjusted OR	1	0.73 (0.22,2.45)	1.44 (0.28,7.21)	1.08 (0.08,14.07)	>0.01(no sig)
	Adjusted OR	1	0.85 (0.25,3.17)	0.95 (0.17,5.27)	0.74 (0.05,10.69	>0.01(no sig)
Rt. Axis deviation (%)	Unadjusted OR	1	1.26 (0.38,4.20)	1.78 (0.36,8.81)	1.34 (0.10,17.28)	>0.01(no sig)
	Adjusted OR	1	1.22 (0.33,4.45)	2.42 (0.44,13.42)	1.81 (0.11,29.18)	>0.01(no sig)
RBBB (%)	Unadjusted OR	1	2.09 (0.46,9.38)	6.8 (1.23,37.50)	2.83 (0.19,41.99)	>0.01(no sig)
	Adjusted OR	1	3.46 (0.89,13.45)	8.43 (2.14,45,32)	4.79 (0.85,54.24)	>0.01(no sig)
AF (%)	Unadjusted OR	1	0.63 (0.14,2.77)	2.5 (0.52,11.89)	1 (0.08,11.93)	>0.01(no sig)
	Adjusted OR	1	0.33 (0.06,1.78)	8.7 (1.13,66.97)	3.08 (0.15,64.57)	>0.01(no sig)
RVH ECG	Unadjusted OR	1	0.78 (0.24,2.56)	0.83 (0.19,3.64)	1 (0.11,8.56)	<0.01(sig)
	Adjusted OR	1	0.72 (0.21,2.42)	1.88 (0.39,9.03)	2.19 (0.16,29.51)	<0.01(sig)
Low voltage ECG (%)	Unadjusted OR	1	0.46 (0.12,1.78)	0.69 (0.14,3.49)	1.86 (0.21,16.18)	<0.01(sig)
	Adjusted OR	1	0.64 (0.15,2.76)	0.6 (0.10,3.50)	4.48 (0.31,65.56	>0.01(no sig)

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Table 17. Association between smoking status with ECG Abnormalities

ECG Abnormality	Smoking Status				Test for Trend
	No	01-25	26-50	51-100	
AF (%)	1	1.33 (0.23,7.80)	2.49 (0.54,11.44)	5.33 (0.52,4.03)	<0.01(sig)
Rt Axis Deviation (%)	1	2.7 (0.23,30.85)	1.93 (0.54,6.87)	2.48 (0.58,10.62)	>0.01(no sig
P-Pulmonale (%)	1	1.6 (0.37, 7.02)	0.7 (0.19, 2.45)	1.75 (0.15,20.23)	>0.01(no sig
S1S2S3	1	1.36 (0.28,6.68)	0.59 (0.11, 3.06	1.25 (0.10,15.49)	>0.01(no sig
S1Q3	1	1.33 (0.23, 7.80)	0.84 (0.15, 4.76	1.78 (0.13,23.40)	>0.01(no sig
Incomplete RBBB (%)	1	0.70 (0.14,3.56)	1.6 (0.42,6.11	0.93 (0.08,11.18)	>0.01(no sig

RVH ECG	1	0.60 (0.15, 2.36)	1.08 (0.31, 3.69)	0.9 (0.10, 7.78)	>0.01(no sig)
Low voltage ECG (%)	1	0.7 (0.14,3.56)	1.93 (0.51,7.32)	0	<0.01(sig)

Table 18: Correlation of ECG abnormalities with FEV1/FVC ratio

ECG changes	Criteria	Total number	FEV1/FVC (%)					P-value	r value
			21-30(n=6)	31-40(n=11)	41-50(n=15)	51-60(n=6)	61-70(n=12)		
P wave axis	$<90^0$	23	1(16.66%)	2(18.18%)	6(40%)	5(83.33%)	9(75%)	0.010556 (sig)	0.5 86
	$\geq+90^0$	27	5(83.33%)	9(81.81%)	9(60%)	1(16.66%)	3(25%)		
QRS axis	$<90^0$	30	2(33.33%)	5(45.45%)	9(60%)	4(66.66%)	10(83.33%)	0.2327(no sig)	0.7 10
	$\geq+90^0$	20	4(66.67%)	6(54.54%)	6(40%)	2(33.34%)	2(16.67%)		
P wave height in mm	<2.5	31	1(16.66%)	7(63.63%)	9(60%)	5(83.33%)	9(75%)	0.1212(sig)	0.6 62
	≥2.5	19	5(83.33%)	4(36.36%)	6(40%)	1(16.66%)	3(25%)		
RV6 height in mm	>5.0	30	2(33.33%)	5(45.45%)	9(60%)	4(66.66%)	10(83.33%)	0.2327(no sig)	0.349
	<5.0	20	4(66.67%)	6(54.54%)	6(40%)	2(33.34%)	2(16.67%)		
RBBB	Absent	30	6(100%)	4(36.36%)	8(53.33%)	2(33.34%)	10(83.33%)	0.059	- 0.1 76
	Present	20	0	7(63.63%)	7(46.67%)	4(66.66%)	2(16.67%)		
RV1height in mm	<7	36	6(100%)	6(54.54%)	11(73.33%)	1(16.66%)	12(100%)	0.012 (sig)	- 0.3 74
	>7	24	0	5(45.45%)	4(26.67%)	5(83.33%)	0		

Table 19. Distribution of pulmonary hypertension with COPD severity

SEVERITY OF COPD	NORMAL	MILD PAH	MODERATE PAH	SEVERE PAH	TOTAL
MILD	2	1	0	0	3
MODERATE	5	3	2	1	11
SEVERE	12	1	3	4	20
VERY SEVERE	1	2	4	9	16

DISCUSSION

The purpose of the present study was to correlate the relationship between ECG abnormalities in COPD patients and to analyze these changes with spirometry. ECG alterations in COPD patients were investigated and connected to disease severity in this study.

Demographics: The age of the patients in this study ranged between 41 to 84 years and the mean age was 65.26+9.525 years. This correlated with the Vivek katiyar et al [8] group where the mean age group was 65.60 ± 9.90 years in moderate and 57.80+9.08 in the severe group. The mean age in patients in a study done by Sruthi et al44 was 65.6+9 years..In this study, the male to female ratio was 4:1. In males and females, Vinod Singh et al [11] found 86 percent and 14 percent, respectively. Due to higher exposure to smoking, there was a male preponderance in every research.

The mean BMI of the patients in our current study was 21.86 ± 2.52 kg/m2. The mean BMI was 22.3 in the mild group, 21.9 in the moderate group, 22.1 in the severe group, and 20.3 in the very severe group. Eckerbald et al [12] showed 26.8±5.7kg/m2 . Mateo Sainz et al [13] conducted a study that was identical to this with a mean BMI of 22.4 kg/m2 . But in the recent meta-analysis done by Cao et al [14] a total of 17 observational studies have shown that obesity and overweight were associated with lesser mortality. This is called "OBESITY PARADOX." This is applicable only in patients with BMI less than 30 kg /m2. Eighty percent of the patients in this study were smokers, which matches the findings of Erin Mitski et al and Kutum et al[15] . Smoking is the most frequent etiological risk factor for COPD, according to Jindal et al [16] . In our current study, 68.7 % were beedi and chutta smokers and cigarette smoking was found in 25% of males. This may be accounted to the rural background of most of the patients. This corresponds to the findings noted in N K Jain et al [17], and Gothi et al [18] According to Jindal et al[33] the average pack-years of smoking in this study was 20.67±6.5 years. Most of the patients had a 20-pack-year smoking history. 15 of the patients had smoked for 20 to 25 years. In our current study, 12% of the patients were Non-Smokers, i.e., exposure to Bio combustibles and occupational exposure was present. All of them were females. The findings noted were lesser than the other studies like 18% in NK Jain et al [17] According to our findings, the prevalence of Mild, Moderate, Severe, and Very Severe diseases was 6%, 2%, 40%, and 32%, respectively. The current findings are consistent with those of Aggarwal et al[9], who found mild airflow limitation (30 percent and 30.5 percent), moderate airflow limitation (44 and 42%), and severe airflow limitation (26% and 27.4%) in patients.

In our current study, the mean ± SD of FEV1% was 81.3 +0.57, 63.9+6.28, 41.15+4.59, and 25.625+2.41% in GOLD 1, GOLD 2, GOLD 3, and GOLD 4, respectively.

In the study done by Jatav et al[11] analysis of the chest x-ray showed an emphysematous chest in 72 % of the patients. This is correlative with the present study. 42 % had increased broncho vascular markings suggestive of chronic bronchitis. Cardiomegaly was found in 20 cases (20%) and prominent pulmonary vasculature was found in 30 cases (30%). In the study done by Chaudhari et al in 102 patients, 80 % had an emphysematous chest in a chest X-ray. Cardiomegaly was found in 24% of the patients. The prominent right descending artery was found in 30% of the patients. In the study done in 183 patients by Elizabeth Pandey [19], the chest x-ray is suggestive of COPD but not diagnostic. The sensitivity and specificity were 35 %and 87% respectively. One-third of the patients with positive chest x-ray did not have a spirometric diagnosis of COPD. This has the potential to cause misdiagnosis and errors in the correct detection of the disease. According to Arun et al study[18], 77% of the patients experienced emphysema

symptoms. In 50% of the patients, broncho vascular markings were enlarged, indicating chronic bronchitis. In 22 percent of the patients, X-ray evidence of pulmonary hypertension, such as a prominent right descending pulmonary artery (RDPA), and cardiomegaly on X-ray, was seen. When the ECG abnormalities were correlated with the length of symptoms, 'p' pulmonale, right axis deviation, RVH, and partial RBBB all increased with the duration of the condition, although only right axis deviation had statistical significance. In this study with 50 patients, right axis deviation was observed in 17 of them (34%). 26 patients (52%) had right ventricular hypertrophy (R/S in v1 >1 mm and R/S in V6 1 mm), 16 patients (32%) had P pulmonale, and only a handful exhibited atrial fibrillation (22%) and low voltage complexes (40%).

In our present study, the most frequent ECG changes observed were P wave axis ≥+90° (54%), QRS axis > +90° (40%), P wave height ≥ 2.5 mm in lead II (38%), R wave in V6 ≤ 5 mm (28%) and R/S ratio in V5V6 ≤ 1 (28%). 14 patients had R wave in V1 > 7 mm (28%), and RBBB (40%). Whereas study by Deepak Gupta et al39 shows that the most frequent ECG changes observed were P wave axis ≥+90° (64%), QRS axis > +90° (40%), P wave height ≥ 2.5 mm in lead II (38%), R wave in V6 ≤ 5 mm (28%) and R/S ratio in V5V6 ≤ 1 (26%), R wave in V1 > 7 mm (2%), and RBBB (4%).

The present study shows 42% of patients had FEV1/FVC ratio between 41-60, as most of the patients belong moderate degree of airflow limitation, which is comparable with that of MK Tandon and V.K. Singh et al[20] study groups which consist of FEV1/FVC ratio 36.4% and 52.3% respectively. These findings point to a strong unfavorable relationship between the FEV1/FVC ratio and the occurrence of various electrocardiographic abnormalities. The findings of the V.K. Singh et al[20]. study group were highly correlated in the current investigation. In COPD, hypoxia is related to the severity of airway obstruction. In this investigation, there was a strong negative connection between ECG alterations and an FEV1/FVC ratio spirometry assay. Right axis deviation was identified in 52% of patients in the Chaudhari et al study, of 102 patients, followed by P pulmonale (44). In 44% of the cases, right ventricular hypertrophy was observed. Low voltage complexes were detected in 28.8% of the samples, compared to 13.3% in this investigation. This is due to the small number of patients in the current study. Incomplete RBBB was detected in 8% of the patients, which is lower than the current study's findings. The p pulmonale configuration was higher in the severe group (75%). This correlated with Chaudhari et al[32] where it was 54.8% in the severe group. On correlating the ECG changes with the duration of symptoms, the corpulmonale changes were statistically significant (p value =0.001). In the study conducted by Sruthi et al[10]. in 120 patients, the most common abnormality was p pulmonale (37.7%) which was similar in our current study. RVH was found in 24.59 % of the patients which is less when compared to the present study. RBBB was found in 9.84 % which is almost correlative to the present study. Right axis deviation was present in 19.67 % and a severe group, it was around 45 %. Though the overall percentage of right axis deviation was 41.6 % in our current study, it was 66.6 % in the very severe group. Hence all the studies have shown that the right ventricular and right atrial changes were quite high in severe and very severe groups. (p=0.001) Out of the 62 patients in the study done by Venkateswara et al 21 patients had normal ECG. P pulmonale is the most prevalent ECG anomaly, accounting for 32.25% of all cases. Right axis deviation was observed in 12.9 %of the cases, while right bundle branch block was observed in 8.06% of the cases. The presence of P pulmonale in the ECG was associated with the severity of COPD. It showed variable percentages in various other studies such as Hina Banker's study [31] (35%) and Vineeth Alexander's

study [21] (52.5%). This variation is due to the variation in the severity of COPD in different studies. In other studies, done by Sarath et al [22]., atrial ectopics, ventricular ectopics, and atrial fibrillation were seen in more than 50% of the patients. Atrial fibrillation in our current study was 13.3 % of which 22.2 % of the patients were in the very severe group. In the study by Deepak Gupta et al[7] p pulmonale and right ventricular changes were more common. There was a significant negative correlation between FEV1 and ECG changes. The cor pulmonale alterations, according to Jayadev et al [23], are caused by the vertical alignment of the heart caused by right ventricular hypertrophy. ECHO can be used to screen COPD patients, according to Vikram B et al [24]. When it comes to detecting pulmonary artery hypertension, it's non-invasive and more sensitive than an ECG. Because of the small sample size, there are discrepancies in the ECG findings in this study. The present study observed that COPD patients with positive ECG changes such as P wave axis >+90°, QRS axis > +90°, P wave height in lead II > 2.5 mm, and R wave in V6 < 5 mm had a significant reduction in mean FEV1 values, which was statistically significant. However, R/S ratio in V5/V6 < 1, R wave in V1 > 7 mm, and RBBB. Whereas study by Deepak Gupta et al[39].also observed comparable results which show that COPD patients with positive ECG changes. P wave axis + 900, QRS axis + 900, P wave height 2.5 mm in lead II, R wave in V6 5mm seen in grade II and III severity were the most common ECG abnormalities in our current study, which is statistically significant. V5/V6 R/S ratio 1, RBBB, and R wave V1 > 7 mm were also common. COPD patients with lower FEV1/FVC percent values had more ECG abnormalities. In the present P wave axis >+90° is a common ECG abnormality, Next common ECG changes were QRS axis > +90°, P wave > 2.5 mm in lead II and R wave in V6 < 5 mm (7). The study groups showed an equal percentage of R/S ratio in V5/V6 < 1, which is the common ECG abnormality.

Pulmonary arterial hypertension, i.e., pulmonary arterial pressure more than >30 mm of Hg was found in 60% in our study. Pulmonary hypertension is present in 2%, 12%, 16%, and 30% cases of mild, moderate, severe, and very severe obstruction, respectively. This reveals that pulmonary hypertension is present more commonly in severe cases than in milder cases. where 21.7% of the moderate group, 68.1% of the severe group, and 88.2% of the very severe of the group had PAH. The distribution of PAH in the Jatav et al[11]. trial was 40.90%, 36.36%, and 63.33 %in the moderate, severe, and very severe groups, respectively. This has a negative relationship with COPD severity and pulmonary arterial hypertension. Only moderate and severe groups were studied in the investigations conducted by Sruthi et al[10]., Katiyar et al[8]., and Gupta et al[7]. In Katiyar et al[8], the total prevalence of PAH was 38.8%, which was lower than the other categories. There was no association between COPD severity and PAH severity in this investigation. In N K Gupta et al[17] study, 54.6% of moderate COPD patients and 60% of severe COPD patients had pulmonary arterial hypertension. In Chokshi et al [26]., 50% of moderate COPD patients and 27.8% of severe COPD patients had pulmonary arterial hypertension. All these investigations have observed an association between the severity of COPD and PAH.

In our current study, 14 %, 18 %, and 28% of the study population had mild, moderate, and severe PAH, respectively. The findings noted in our current study population were less when compared to other studies due to less sample size. Comparison of p pulmonale distribution P pulmonary is responsible for 15 to 20% of heart failure and 7-10% of heart disorders. This was more common among smokers in their 50s and 60s. The Right Ventricle gradually hypertrophies and dilates in response to increased pulmonary vascular resistance (PVR). Severe PAH causes an increase in right ventricular afterload, as well as an

increase in right ventricular work, resulting in uniform right ventricular hypertrophy. In our current study, 32% of the study population had p pulmonale.17.5% of the study population in N K Gupta et al[17]. had pulmonale. 32 percent of the study sample had pulmonale, according to Kaushal et al [27]. Alok Agarwal et al[9]. (92%) and Jatav et al[11]. (92%) had much higher findings (82 percent). As a result, ECG and ECHO examinations are required for all COPD patients, as they aid in the early detection and management of heart problems.

In our study, 33.33 percent of those in the mild category exhibited ECG alterations, 45.45 percent in the moderate category, 55% in the severe category, and 93.75 percent in the very severe category. Padmavati and Raizada et al[6], as well as Jatav et al[11], found comparable results. In this present study, Right Ventricular Hypertrophy is 33.3%, 36.36%, 50%, and 68.75% in mild, moderate, severe, and very severe obstructions respectively, which shows that right ventricular Hypertrophy increases with COPD disease severity. In our study, 33.33 percent of those in the mild category exhibited ECG alterations, 45.45% in the moderate category, 55% in the severe category, and 93.75 percent in the very severe category. Padmavati and Raizada et al[6] as well as Jatav et al[11] found comparable results[28,29]. A study published in the journal LUNG INDIA in 2011 observed that pulmonary hypertension, right ventricular and left ventricular dysfunction are more prevalent and their occurrence correlated well with the severity of COPD [30]. There is an ECG change in mild category COPD patients, i.e., RVH was detected in 1 out of 3 individuals (33.33%). RVH was found in 50 percent of severe category patients, 36.36% of moderate category patients, and 68.75 percent of extremely severe category patients, respectively. P. Pulmonale was found in 0% of mild category patients, while it was found in 9.09 percent, 20%, and 68.7% of moderate, severe, and very severe patients, respectively. RAD was found in 0 percent of mild category patients, but 9.09%, 50%, and 37.5% of moderate, severe, and profoundly serious patients, respectively. Poor R wave progression was noted in 0% of mild category patients, but 9.09%, 20%, and 56.25% of moderate, severe, and very severe category patients, respectively. RBBB was seen in 0 percent of mild category patients, but 18.18 percent, 35 percent, and 68.75% of moderate, severe, and very severe patients, respectively. Patients in the mild category had no atrial fibrillation, but those in the moderate, severe, and very severe categories had 18.18 percent, 15%, and 37.5 percent, respectively. These ECG anomalies were found to have a substantial association with COPD disease categories. Padmavati and Raizada et al[6], as well as Jatav et al[11], found comparable results. There was a negative correlation observed between increasing FEV1/FVC percent and the occurrence of electrocardiographic abnormalities, a more active strategy to treating COPD patients can be taken to delay the start of corpulmonale as much as feasible. According to the findings, the severity of problems rises in lockstep with the severity of COPD, forming a linear relationship. Changes in the ECG were shown to be highly associated with the severity of the condition.

SUMMARY -Among 50 COPD patients, 40 of them were men and 10 were women. Most of the patients were between the ages of 51 and 80. Among the COPD cases, the majority (40%) were belonging to severe airflow limitation (GOLD C), followed by very severe (32%), moderate (22%), and mild (6%) categories. The most common ECG abnormality was Right ventricular hypertrophy (52%), followed by RBBB in 40%, Right axis deviation in 34%, P pulmonale saw in 32%,and Atrial Fibrillation observed in 22% of patients. There was a significant correlation between the severity of the condition is related to the ECG results. The incidence of P-

Pulmonale, Right Axis Deviation (RAD), Right Ventricular Hypertrophy (RVH), and Right Bundle Branch Block (RBBB) among ECG abnormalities had a statistically significant link with severity. ECG changes were statistically correlated with the length of symptoms. 'p' pulmonale, right axis deviation, RVH, and RBBB were increased with the duration of the condition. Most of the patients (40%) were in GOLD stage III, with right ventricular hypertrophy being the most prevalent ECG abnormality. The most common ECG changes were P wave axis >+90° (54%), followed by 40% in QRS axis> +90°, R/S ratio in V5V6 1, and P wave height > 2.5 mm in lead II (38%) and (28%). FEV1, FEV1/FVC ratio, and ECG alterations all had a strong negative connection. The incidence of various electrocardiographic characteristics has a substantial negative connection with the FEV1/FVC ratio. COPD patients with a poor FEV1/FVC percent ratio had more ECG abnormalities. Upon ECG change, RVH was detected in 1 case of mild category, and 50%, 36.36%, and 68.75% of severe, moderate, very severe category patients. P. Pulmonale was found in 9.09%, 20%, and 68.7% of moderate, severe, and very severe patients. RAD was found in 9.09%, 50%, and 37.5% of moderate, severe, and very serious patients. Poor R wave progression was noted in 9.09%, 20%, and 56.25% of moderate, severe, and very severe category patients. RBBB was seen in 18.18%35%, and 68.75%of moderate, severe, and very severe patients, respectively. Patients in the moderate, severe, and very severe categories had 18.18%, 15%, and 37.5%, respectively. The severity and duration of the disease contribute to the increased incidence of AF. Smokers are more likely to experience AF and right axis deviation. In our current study, a Negative correlation was found between the FEV1/FVC values and the incidence of various electrocardiographic features. (r=-0.594**, - 0.710, -0.661, -0.176, and -0.374 for P wave axis > +90°, QRS axis >+90°, P wave height > 2.5 mm in lead II, R wave in V1 > 7 mm, and RBBB). Overall, ECG changes significantly correlated with disease severity. To avoid cardiac mortality and morbidity, all COPD patients should have a cardiac examination using an ECG to detect early cardiac problems.

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